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भाग 2 वर्गीकरण

Indian Standard

MECHANICAL VIBRATION AND SHOCK — VIBRATION AND SHOCK IN BUILDINGS WITH SENSITIVE EQUIPMENT

PART 2 CLASSIFICATION

ICS 17.160; 91.120.25

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NEW DELHI 110002

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Price Group 5

Mechanical Vibration and Shock Sectional Committee, ME 28

NATIONAL FOREWORD

This Indian Standard (Part 2) which is identical with ISO/TS 10811-2 : 2000 'Mechanical vibration and shock — Vibration and shock in buildings with sensitive equipment — Part 2 : Classification' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendations of the Mechanical Vibration and Shock Sectional Committee and approval of the Mechanical Engineering Division Council.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to the following International Standard for which Indian Standard also exists. The corresponding Indian Standard which is to be substituted in its place is listed below along with its degree of equivalence for the edition indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO/TS 10811-1 : 2000 Mechanical vibration and shock — Vibration and shock in buildings with sensitive equipment — Part 1 : Measurement and evaluation	IS 15593 (Part 1) : 2005 Mechanical vibration and shock — Vibration and shock in buildings with sensitive equipment: Part 1 Measurement and evaluation	Identical

The concerned Technical Committee has reviewed the provisions of the following International Standard referred in this adopted standard and has decided that this is acceptable for use in conjunction with this standard:

International Standard	*Title*
IEC 61260	Electroacoustics — Octave-band and fractional-octave-band filters

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

MECHANICAL VIBRATION AND SHOCK — VIBRATION AND SHOCK IN BUILDINGS WITH SENSITIVE EQUIPMENT

PART 2 CLASSIFICATION

1 Scope

This part of ISO/TS 10811 defines a method for the classification of shock and vibration in buildings from measurements in accordance with ISO/TS 10811-1. A classification system of environmental vibration conditions should serve as guidelines for designers, manufacturers and users of equipment sensitive to shock and vibration, and for building constructors.

The types of shock and vibration considered are those transmitted from floors, tables, walls, ceilings or isolation systems into an equipment unit. They can be generated by the following:

a) external sources, for example traffic (by road, rail or air), or building and construction activities such as blasting, piling and vibratory compaction; the vibration response to sonic booms and acoustical excitations is also included, as well as weather-induced vibration;

b) equipment for indoor use, such as punch presses, forging hammers, rotary equipment (air compressors, air conditioner systems, etc.) and heavy equipment transported or operated inside a building;

c) human activities in connection with the service or operation of the equipment, for example, people walking, especially on raised floors.

The frequency range of interest is normally 2 Hz to 200 Hz. Normally the dominant frequencies are less than 100 Hz because they represent the response of the elements in the building.

This part of ISO/TS 10811 deals only with vibration from a maximum amplitude point of view. The concept of vibration dose (for example as for estimation of fatigue life) is not treated.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO/TS 10811. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/TS 10811 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/TS 10811-1, *Mechanical vibration and shock — Vibration and shock in buildings with sensitive equipment — Part 1: Measurement and evaluation.*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters.*

3 Vibration wave forms

The vibration wave forms in a building that could affect sensitive equipment may be of any kind: sinusoidal (periodic), random or transient. Typical examples of sources for different wave forms are the following:

a) rotating machinery for sinusoidal vibration;

b) road traffic (many vehicles) for random vibration;

c) single road vehicles, piling, impacting and blasting for transient vibration.

The frequency content of the vibration is determined by the source but is also influenced by the dynamics of the building. The methods for measurement and analysis described in ISO/TS 10811-1 may be used for any type of vibration wave form.

4 Classification

4.1 General

The basis for classification is a response-equivalent peak velocity spectrum, as defined in ISO/TS 10811-1. The spectrum may be computed from several events, such as from several passing trains. If several spectra are to be considered, the maximum for each frequency should be taken. Spectra from different types of events can also be considered, using the same principle.

A typical response-equivalent peak velocity spectrum has a low-frequency part with a slope of 6 dB per octave and a high-frequency part with a slope of –6 dB per octave (see Figure A.2 for an example shown in a double-logarithmic presentation). The slope of 6 dB per octave corresponds to constant displacement versus frequency, while the slope of –6 dB per octave corresponds to constant acceleration.

The velocity r.m.s. value, in millimetres per second, is selected from the number series 1×10^n, 2×10^n and 5×10^n where n is a positive or negative integer. The transition frequencies are selected from the octave-band mid-frequencies according to IEC 61260 (see Table 1 or 2).

4.2 Classification procedure

The procedure (which may be performed manually or by a computer program) consists of the following steps.

a) Let a horizontal line of constant velocity drop down on the measured spectrum in a double-logarithmic presentation, using the number series defined above, until at least two spectrum points are above the line. Then go up one level.

b) Let a line of constant displacement (6 dB per octave) drop down on the spectrum until two spectrum points are above the line.

c) Let a line of constant acceleration (–6 dB per octave) drop down on the spectrum until two spectrum points are above the line.

d) The procedure normally generates two transition points. For classification, select for the low-frequency transition point (displacement) the frequency from Table 1 that is the first one lower than or equal to the low-frequency transition point. Select in the same manner from Table 2 for the high-frequency transition point (acceleration) the frequency which is the next higher or equal in frequency. The lowest selected transition frequency is 2 Hz. If the high transition frequency is greater than 125 Hz, 200 Hz shall be taken.

e) An automated procedure may in some cases produce a selected displacement transition frequency that is higher than the selected acceleration transition frequency. In this case, the two frequencies shall be interchanged.

This procedure is explained in annex A, showing the special case of identical selected transition frequencies.

5 Numbers for displacement and acceleration lines

The following approximate numbers may be used for the displacement and acceleration lines. The values in the Tables 1 and 2 are values of displacement and acceleration, respectively. The velocity values given in the tables are 1 mm/s, 2 mm/s and 5 mm/s; for other velocity values, a simple scaling can be used.

Table 1 — Values of the displacement line

Velocity value mm/s	**Displacement values** µm						
	Transition frequency Hz						
	2	**4**	**8**	**16**	**31,5**	**63**	**125**
1	80	40	20	10	5	2,5	1,25
2	160	80	40	20	10	5	2,5
5	400	200	100	50	25	12,5	6,3

Table 2 — Values of the acceleration line

Velocity value mm/s	**Acceleration values** mm/s^2						
	Transition frequency Hz						
	2	**4**	**8**	**16**	**31,5**	**63**	**125**
1	12,5	25	50	100	200	400	800
2	25	50	100	200	400	800	1600
5	63	125	250	500	1000	2000	4000

6 Designation of the environmental vibration condition in buildings

The environmental vibration condition in buildings is designated according to this part of ISO/TS 10811 by three numbers, namely

— the velocity value,

— the selected displacement transition frequency, and

— the selected acceleration transition frequency.

This shall be designated as follows:

Environmental vibration condition according to ISO/TS 10811: ... mm/s, ... Hz, ... Hz.

7 Connection with IEC 60721 and VC curves

7.1 In IEC 60721-3-3, vibration values are given for sinusoidal environmental vibration. The vibration amplitude is given as the displacement amplitude in the frequency range 2 Hz to 9 Hz, and as the acceleration amplitude in the range 9 Hz to 200 Hz. This classification scheme is much like that one given in this part of ISO/TS 10811.

7.2 The VC (Vibration Criteria) curves [IEST-RP-CC012.13] are widely used for microelectronic facilities and comparable sites. The curves have a constant velocity range (given as r.m.s. values in one-third-octave bands) from 8 Hz to 100 Hz. Below 8 Hz, the VC curves give constant acceleration.

The numbers given in Table 3 are applicable for the constant velocity range. According to ISO/TS 10811-1, the corresponding peak velocity can be estimated for sine waves and for random vibration. In Table 3 the sine values are given. For random vibration, the estimation is given for an exposure time of 10 min and two numbers are given, one corresponding to the 8 Hz one-third-octave band and one to the 100 Hz one-third-octave band.

If many different cases of vibration are considered, the method given in this part of ISO/TS 10811 might give a wide frequency range of constant velocity, and in this case the classification might be close to a VC curve.

Table 3 – Velocity values of VC curves

VC curve	R.m.s. velocity µm/s	Peak velocity for sine waves mm/s	Peak velocity for random vibration (10 min) mm/s	
			8 Hz	100 Hz
A	50	0,071	0,22	0,25
B	25	0,035	0,11	0,12
C	12,5	0,018	0,056	0,062
D	6	0,0085	0,027	0,030
E	3	0,0042	0,013	0,015

Annex A
(informative)

Example of a classification procedure

The time history of a blasting is given in Figure A.1.

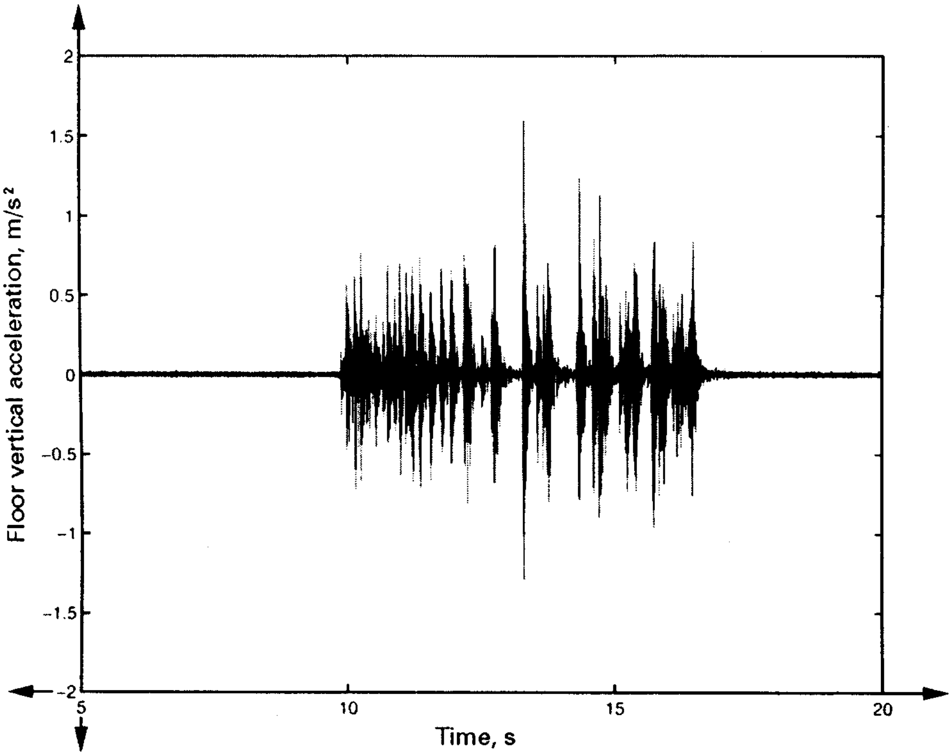

Figure A.1 — Acceleration time history

The response-equivalent peak velocity spectrum with $Q = 10$ according to ISO/TS 10811-1 is given in Figure A.2.

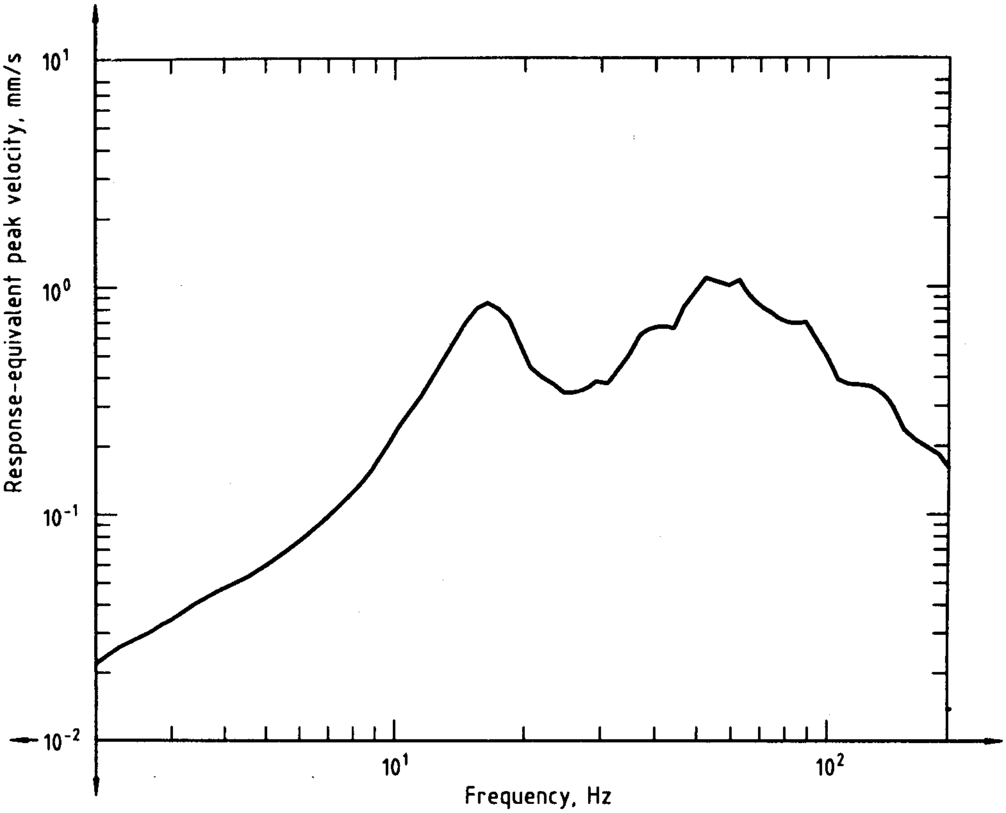

Figure A.2 — Response-equivalent peak velocity spectrum

First the velocity value is searched for, see 4.2, step a). It will be 2 mm/s; see Figure A.3.

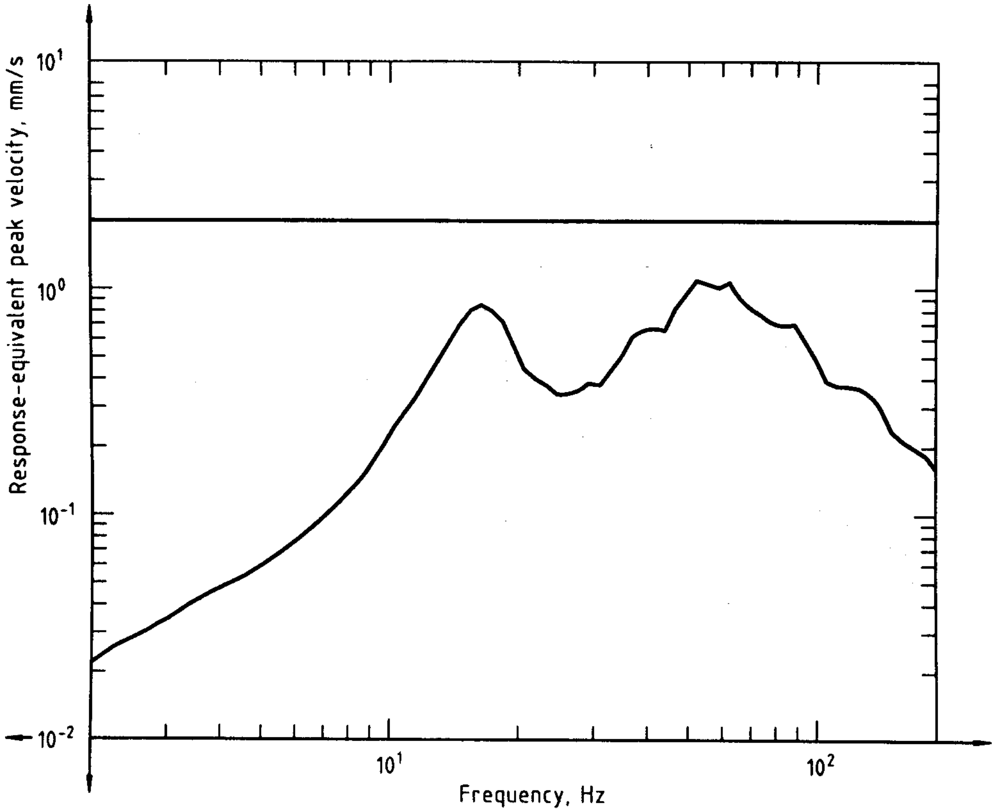

Figure A.3 — Velocity r.m.s. value found

Then the displacement line is determined, see 4.2, step b). It yields a transition frequency of 38 Hz; see Figure A.4.

Then the acceleration line is determined, see 4.2, step c). It yields a transition frequency of 31 Hz; see Figure A.4.

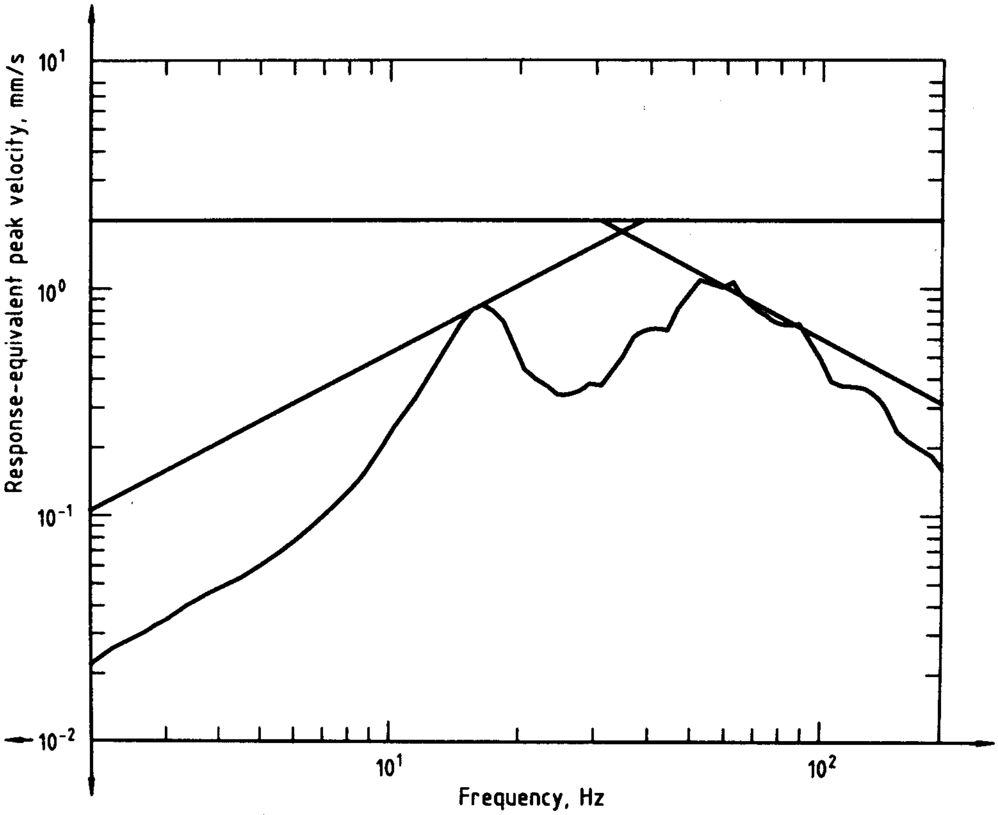

Figure A.4 — Displacement and acceleration lines

According to 4.2, step d), the low-frequency (displacement) transition point is classified according to Table 1 as 31,5 Hz while the high-frequency (acceleration) transition point is classified according to Table 2 as 31,5 Hz. In this special case, both selected transition frequencies became 31,5 Hz. The result is plotted in Figure A.5.

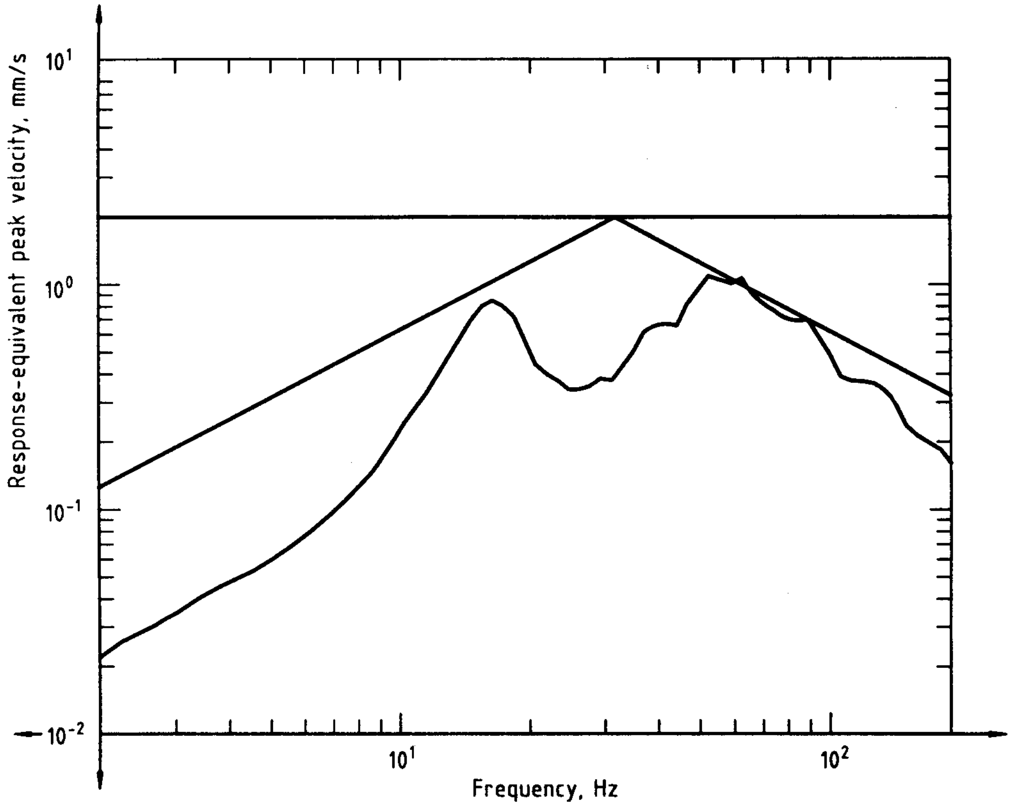

Figure A.5 — Completed classification: 2 mm/s, 31,5 Hz, 31,5 Hz

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[1] ISO 2041, *Vibration and shock — Vocabulary.*

[2] ISO 4866, *Mechanical vibration and shock — Vibration of buildings — Guidelines for the measurement of vibrations and evaluation of their effects on buildings.*

[3] IEC 60068 (all parts), *Environmental testing.*

[4] IEC 60721-3-3:1994, *Classification of environmental conditions — Part 3: Classification of groups of environmental parameters and their severities — Section 3: Stationary use at weather-protected locations.*

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